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Tailoring the structure and the properties of pyrolysed carbon electrodes

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Here we present a study with pyrolysed carbon derived from the photoresist SU-8, polystyrene (PS) and polystyrene-blockpolydimethylsiloxane (PS-PDMS) copolymers (Fig. 1) to evaluate them as electrode material. XPS analysis showed that pyrolysed PS-PDMS contains an atomic percentage of 29% silicon. The silicon content may be a limiting factor for obtaining high-conductive structures due to lower carbon content (19%) compared to PS (96%) and SU-8 (98%), but at the same time the silicon is functioning as support for the 3D structure (fig. 1B). Raman spectra of pyrolysed carbon derived from SU-8 photoresist, revealed the presence of the so called D and G peaks (Fig. 1C), indicating that both amorphous and graphitic regions are contributing. The peak intensity ratio of the D and G peaks varies with the microstructural disorder of the carbon matrix¹. From the Raman spectra, the calculated I_D/I_G is higher for pyrolysed films of PS-PDMS ($I_D/I_G = 1.1$) compared to SU-8 and PS ($I_D/I_G = 1$), indicating higher microstructural disorder of pyrolysed PS-PDMS. Additionally, the standard rate constant for electron transfer (k^0) was determined from the experimental ΔE_p with the method of Nicholson² (table 1). The slower electron transfer kinetics of PS-PDMS compared to PS and SU-8 films may be related to its lower carbon content, as well as to its higher microstructural disorder.

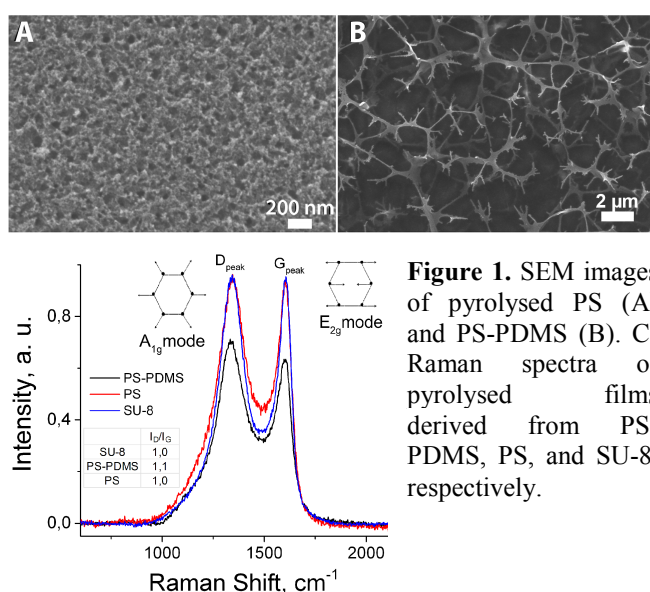


Figure 1. SEM images of pyrolysed PS (A) and PS-PDMS (B). C) Raman spectra of pyrolysed films derived from PS-PDMS, PS, and SU-8. respectively.

Table 1. k^0 values calculated from the experimental ΔE_p of the CVs obtained in 1mM $\text{Ru}(\text{NH}_3)_6^{3+/2+}$, scan rate 10 mV s⁻¹.

Electrode material	ΔE_p (mV)	k^0 (cm s ⁻¹)
PS-PDMS	109	8,0E-02
PS	78	3,3E-01
SU-8	92	1,2E-01

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2. Nicholson, S. R. Theory and application of cyclic voltammetry for measurement of electrode reaction kinetics. *Analytical chemistry* **37**, 1351–1355 (1965).